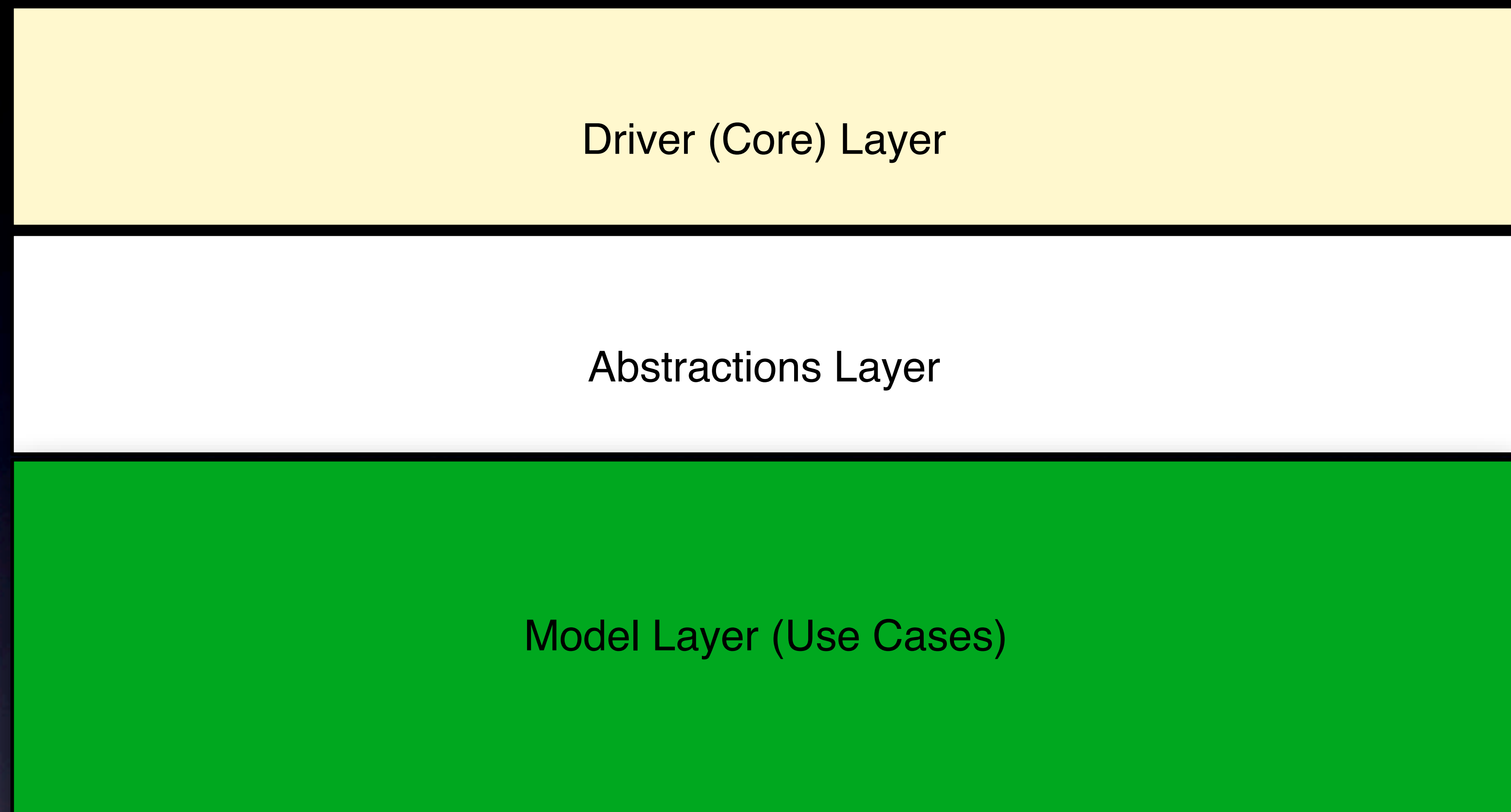
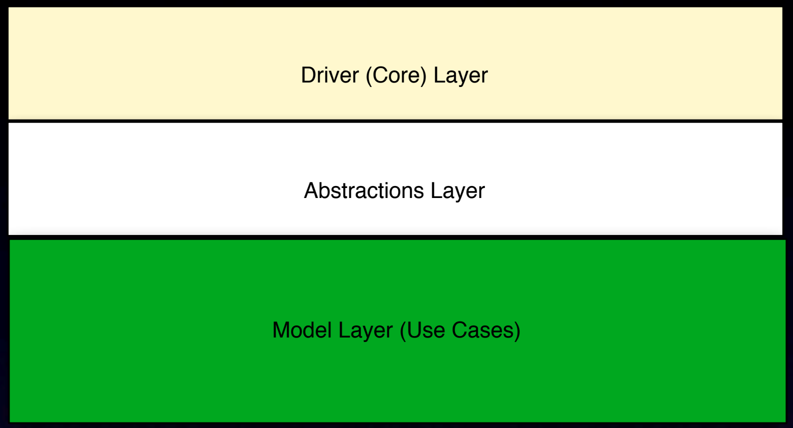
Land Information System
Version 6.0

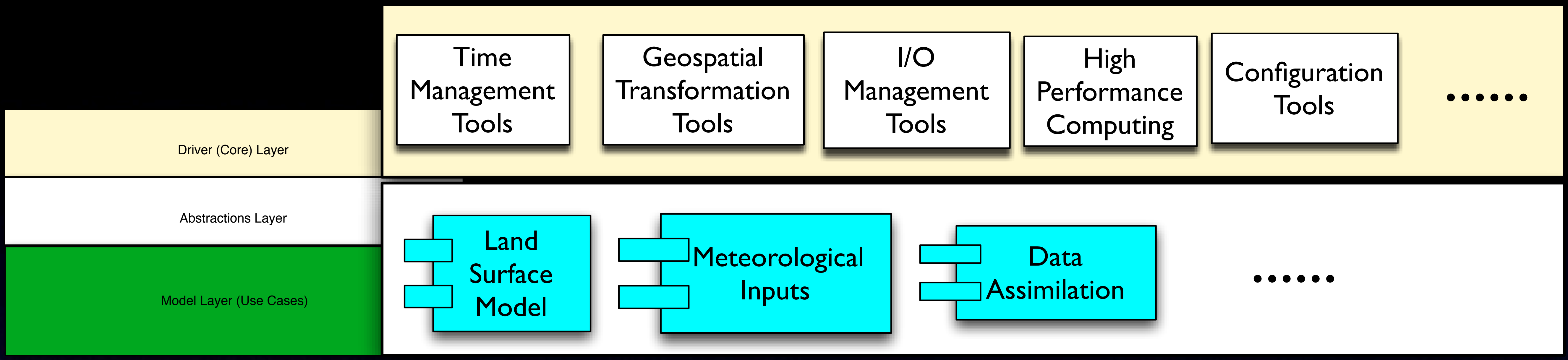


LIS software architecture

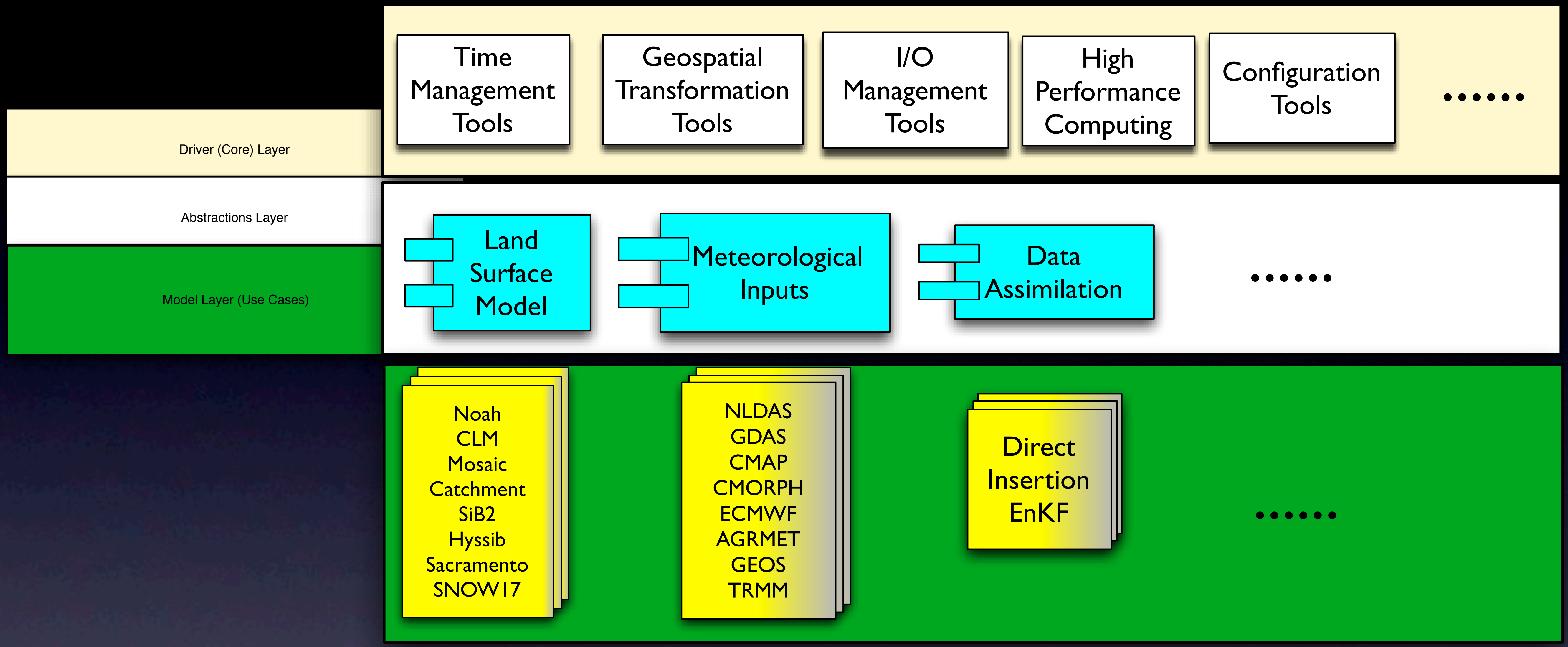


LIS software architecture

LIS software architecture



LIS software architecture



LIS software architecture

Core Layer Enhancements

Uses ESMF3 series

Uses ESMF3 series

Core modules redesigned as “tight containers”

only public methods and variables are exposed

Uses ESMF3 series

Core modules redesigned as “tight containers”

only public methods and variables are exposed

Strict checking of configuration settings

Uses ESMF3 series

Core modules redesigned as “tight containers”

only public methods and variables are exposed

Strict checking of configuration settings

Anew suite of spatial upscaling algorithms

Uses ESMF3 series

Core modules redesigned as “tight containers”

only public methods and variables are exposed

Strict checking of configuration settings

Anew suite of spatial upscaling algorithms

Support for 3d meteorological data

Uses ESMF3 series

Core modules redesigned as “tight containers”

only public methods and variables are exposed

Strict checking of configuration settings

Anew suite of spatial upscaling algorithms

Support for 3d meteorological data

Supports computational halos

Uses ESMF3 series

Core modules redesigned as “tight containers”

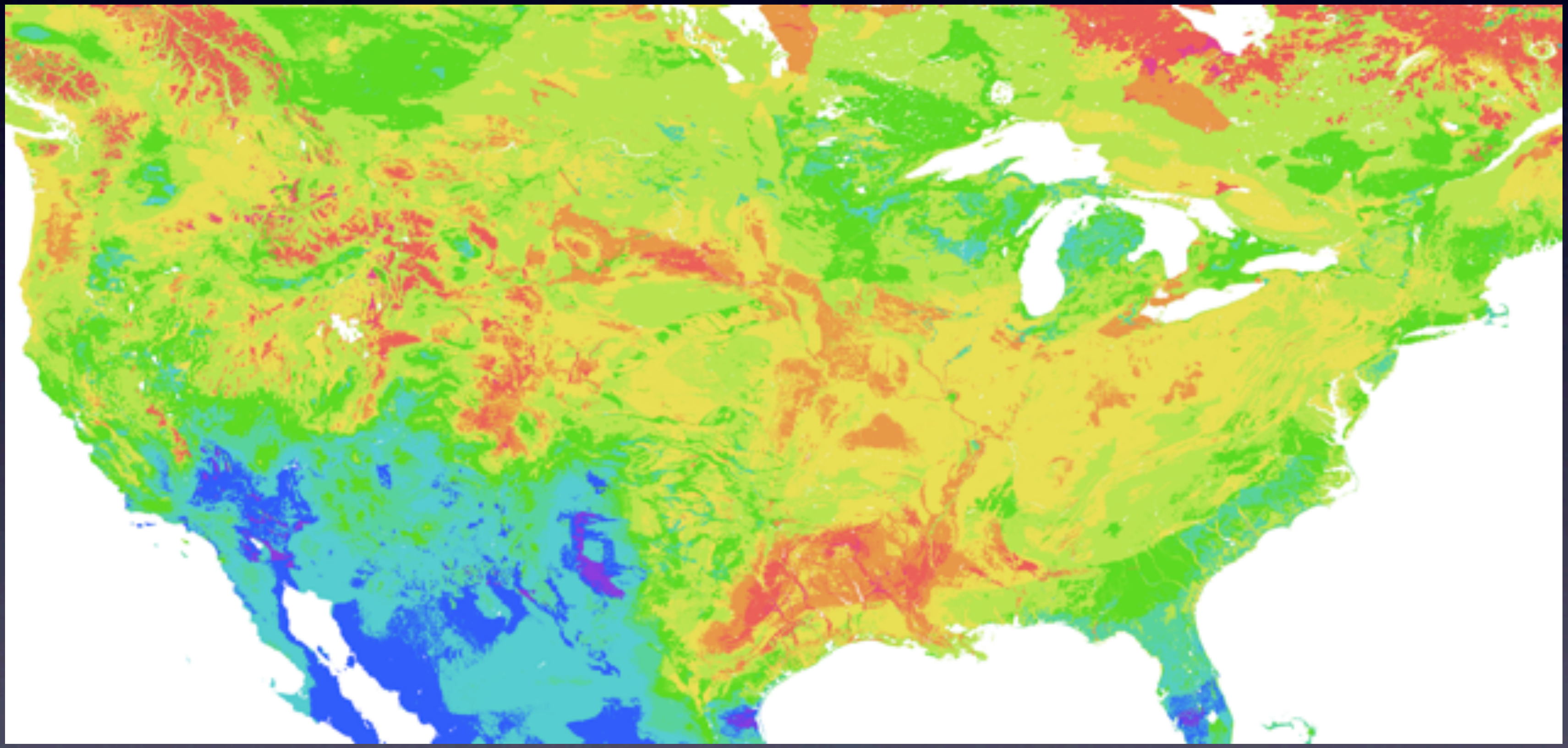
only public methods and variables are exposed

Strict checking of configuration settings

Anew suite of spatial upscaling algorithms

Support for 3d meteorological data

Supports computational halos



Uses ESMF3 series

Core modules redesigned as “tight containers”

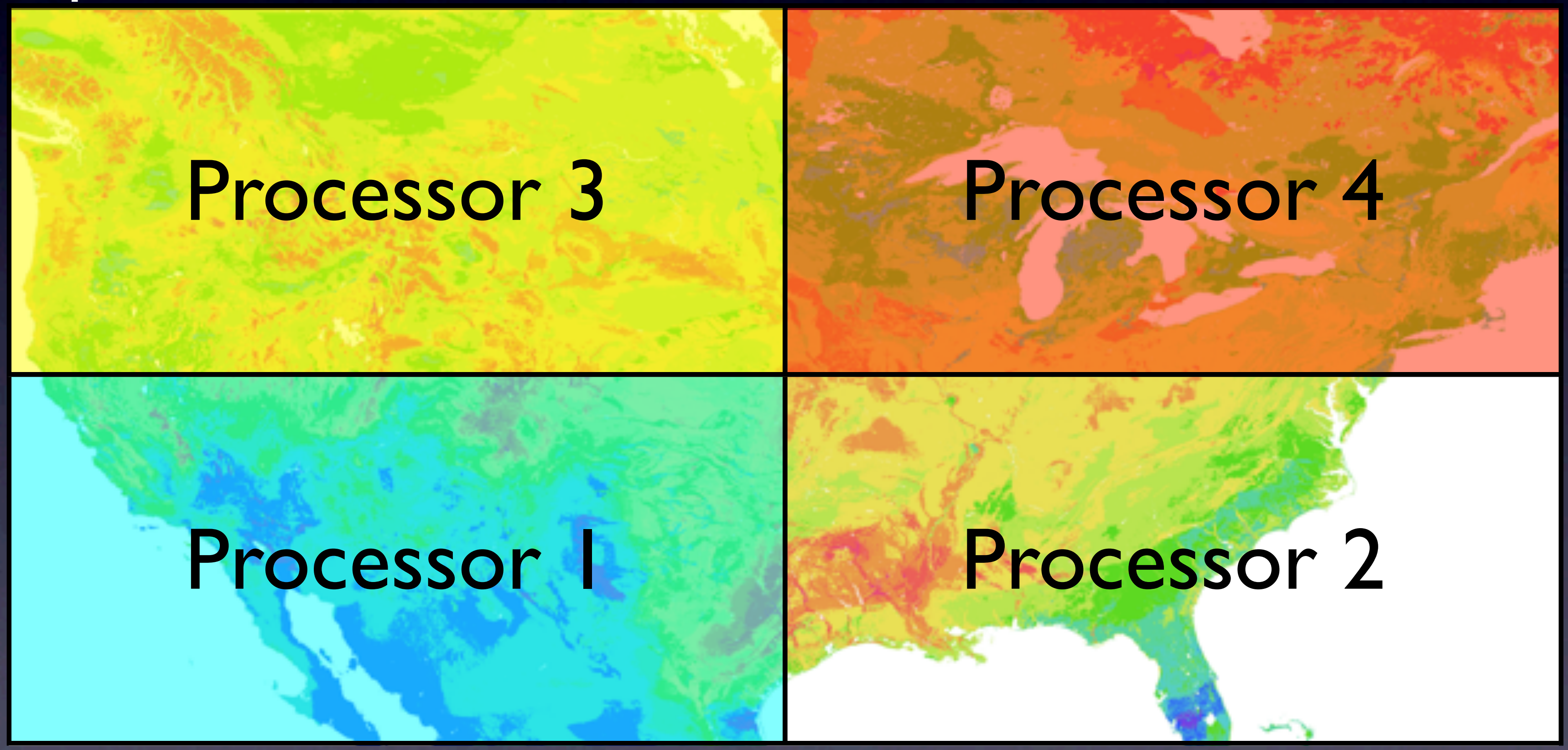
only public methods and variables are exposed

Strict checking of configuration settings

Anew suite of spatial upscaling algorithms

Support for 3d meteorological data

Supports computational halos



Uses ESMF3 series

Core modules redesigned as “tight containers”

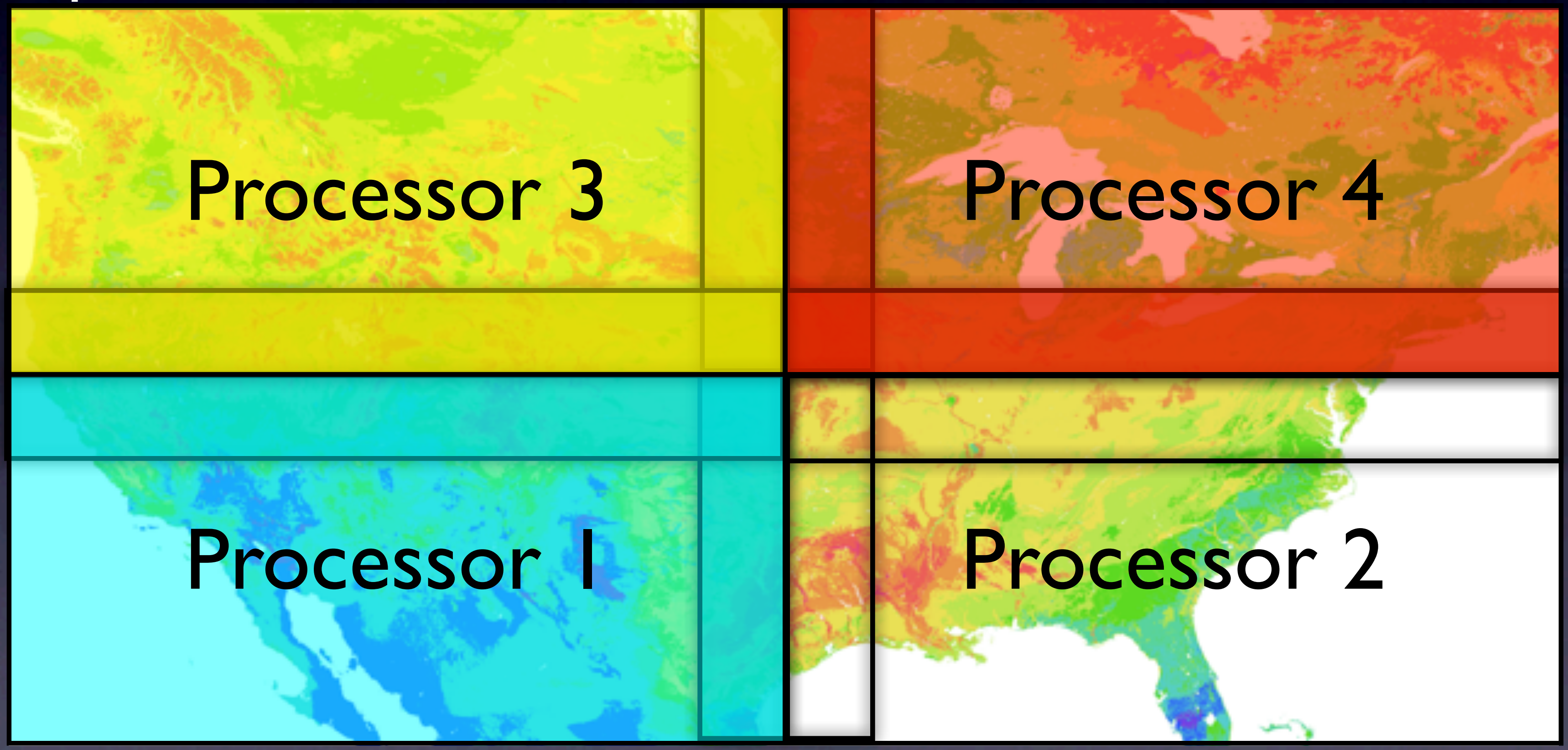
only public methods and variables are exposed

Strict checking of configuration settings

Anew suite of spatial upscaling algorithms

Support for 3d meteorological data

Supports computational halos



Uses ESMF3 series

Core modules redesigned as “tight containers”

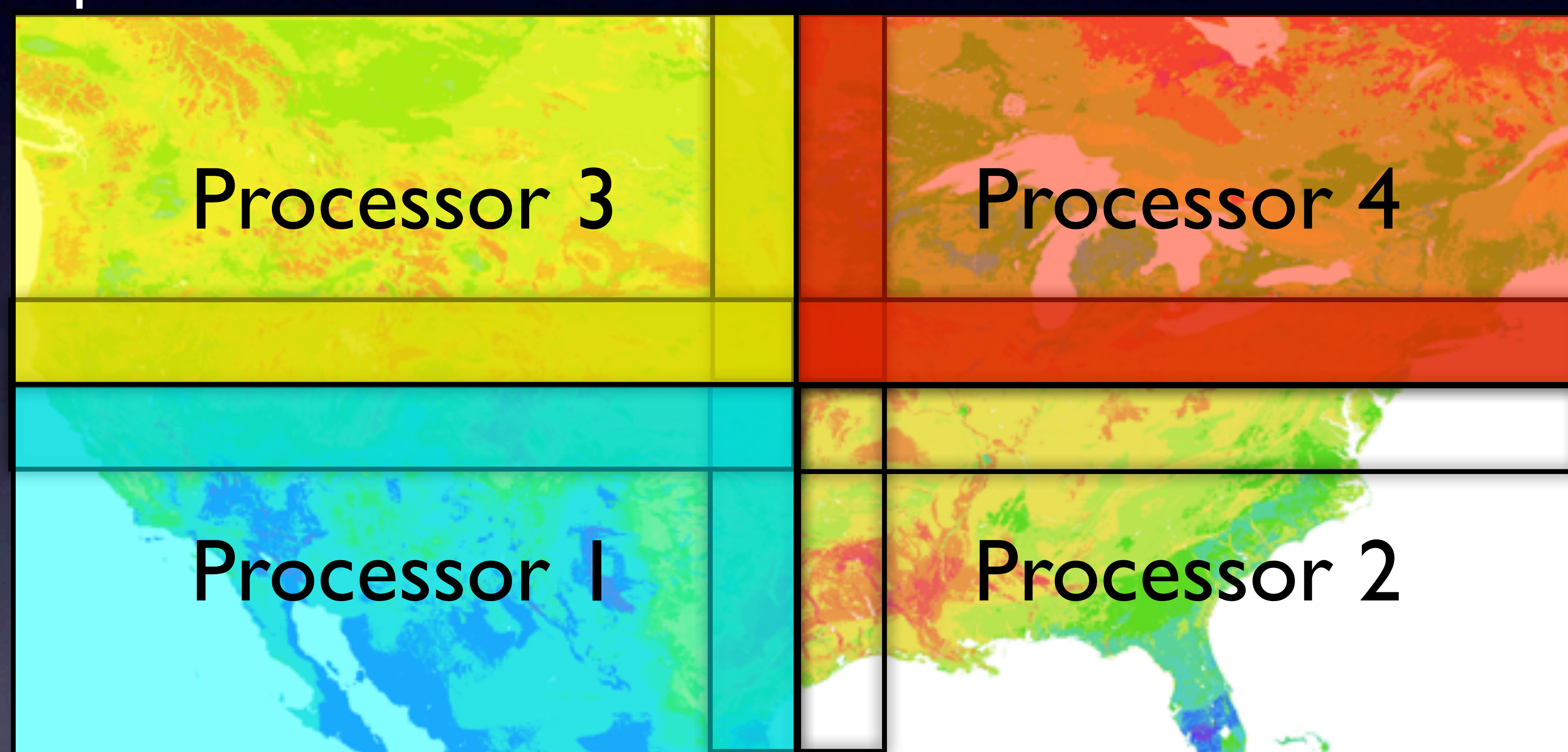
only public methods and variables are exposed

Strict checking of configuration settings

Anew suite of spatial upscaling algorithms

Support for 3d meteorological data

Supports computational halos



Halo size along x: 10
Halo size along y: 10

Configurable I/O

- Model independent
- Binary, Grib1, NETCDF
- Options for unit conversions
- Options for temporal averaging

Configurable I/O

Model independent

Binary, Grib1, NETCDF

Options for unit conversions

Options for temporal averaging

#Name	Select?	Units	Timeavg	Max/min	Vert.levels	Gribid	Grib category
Swnet:	1	W/m2	1	0	1	111	10
Lwnet:	1	W/m2	1	0	1	112	10
Qle:	1	W/m2	1	0	1	121	10
......							
......							
Totalprecip:	1	kg/m2	3	1	1	164	10
......							
......							
SoilMoist:	1	m3/m3	2	0	4	84	1000
......							
#Parameters							
......							
......							
Landcover:	1	--	0	0	1	186	1
......							
......							

Incremental forcing overlays

Incremental forcing overlays

"Spatial Mosaicing" of different forcings concurrently

Incremental forcing overlays

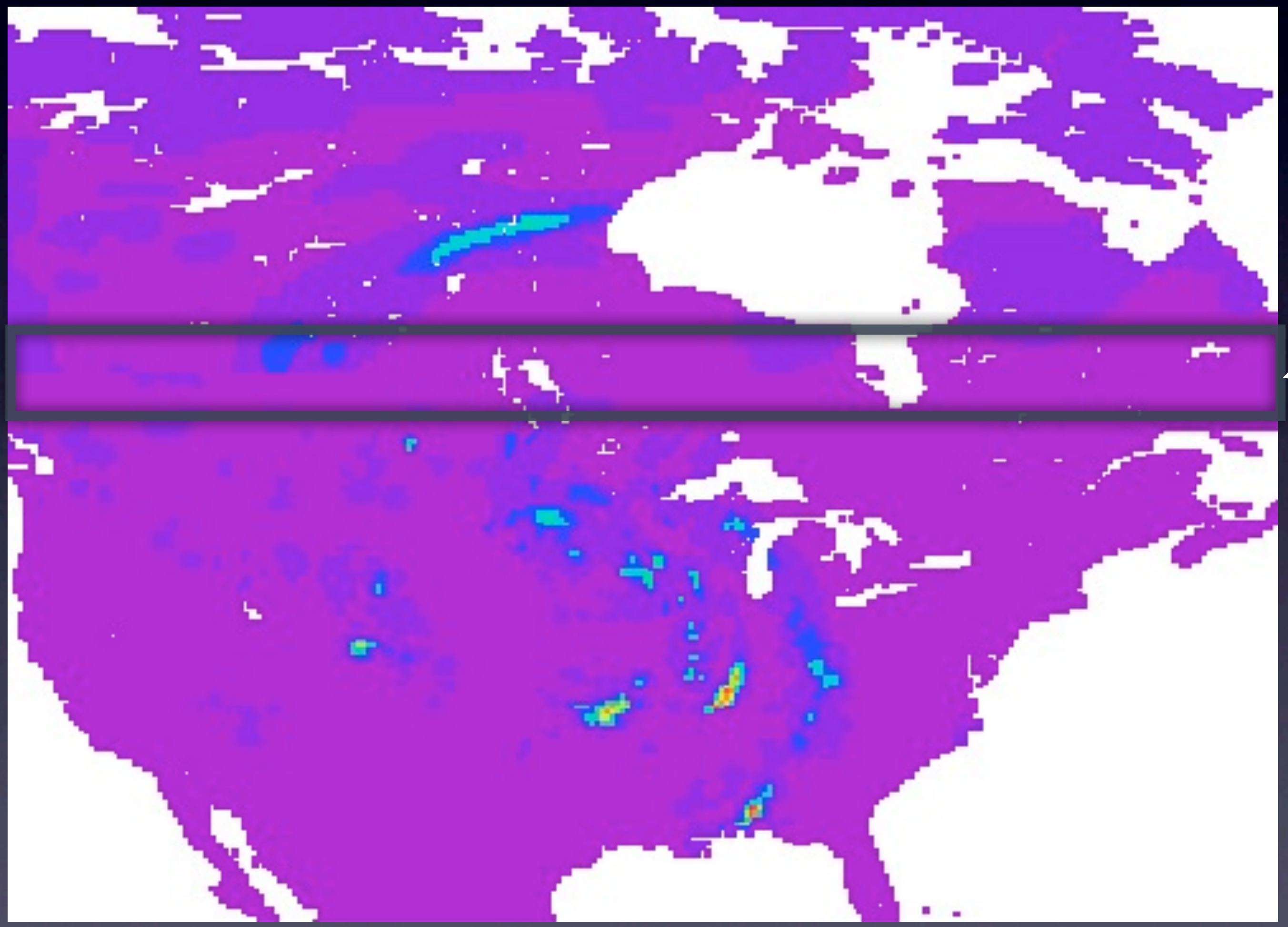
"Spatial Mosaicing" of different forcings concurrently

Multiple, incremental overlays of different supplemental forcings

Incremental forcing overlays

"Spatial Mosaicing" of different forcings concurrently

Multiple, incremental overlays of different supplemental forcings



NLDAS + GDAS

Incremental forcing overlays

"Spatial Mosaicing" of different forcings concurrently

Multiple, incremental overlays of different supplemental forcings

Incremental forcing overlays

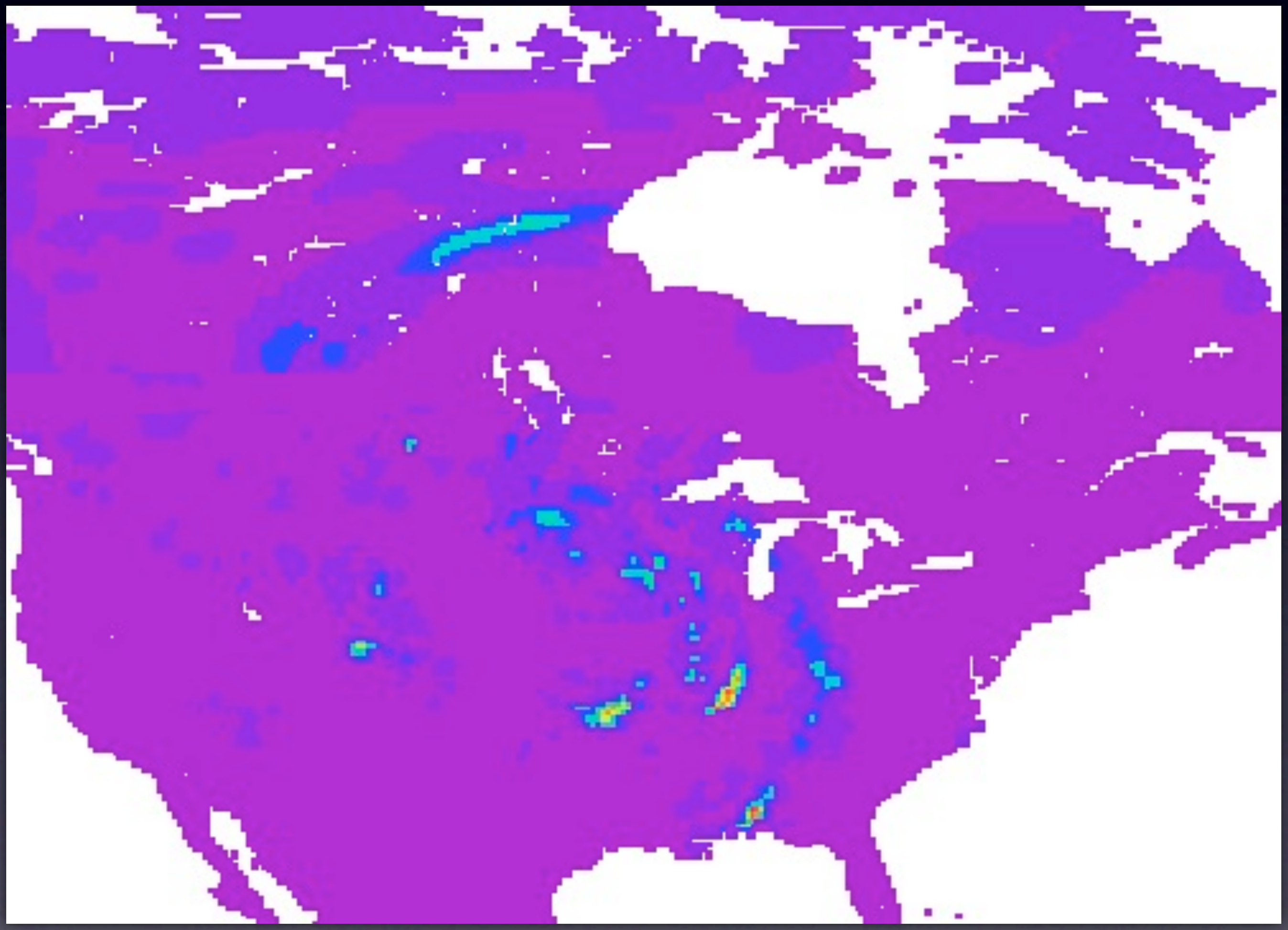
“Spatial Mosaicing” of different forcings concurrently

Multiple, incremental overlays of different supplemental forcings

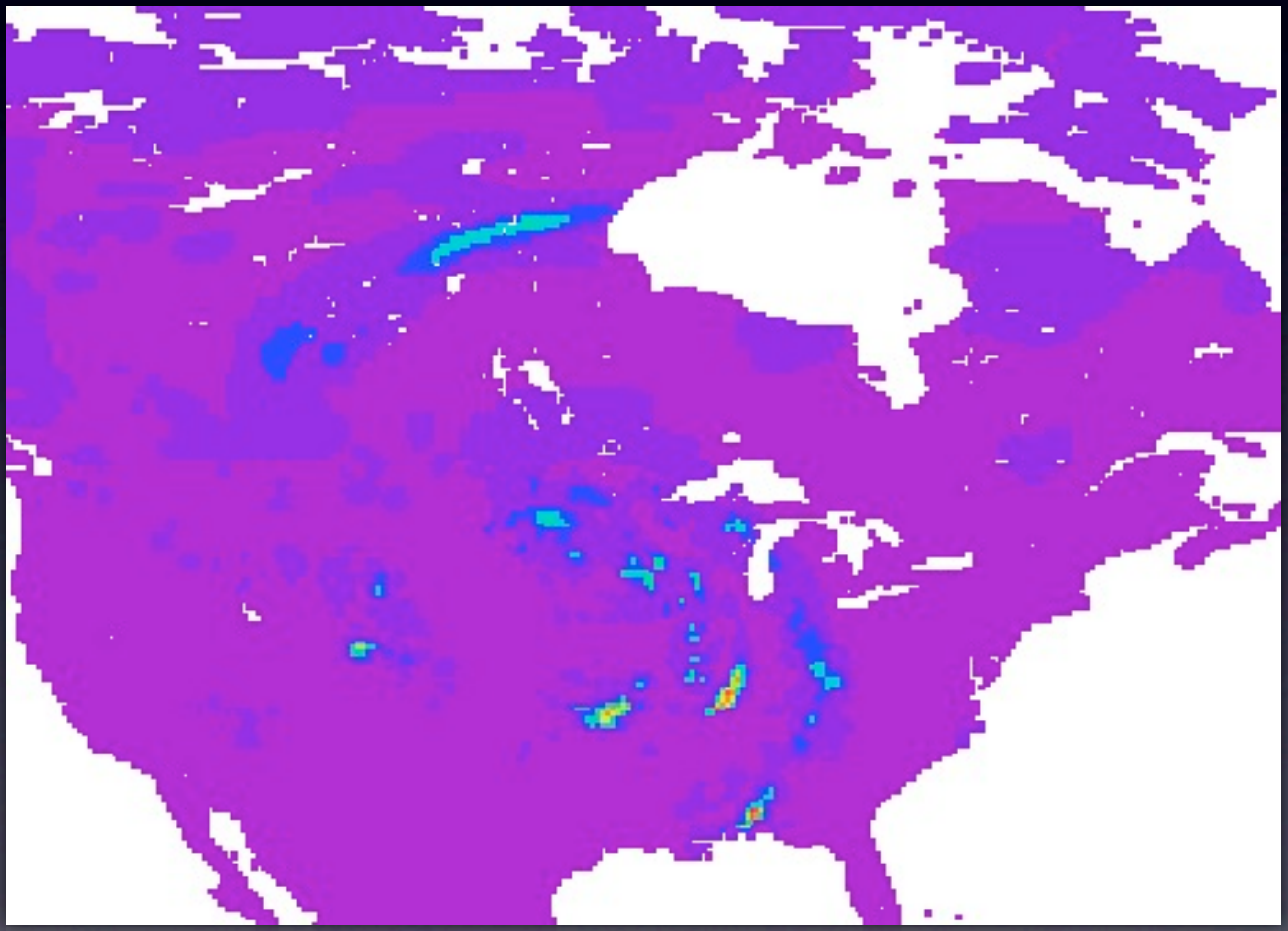
Optional data masks

Incremental forcing overlays

- “Spatial Mosaicing” of different forcings concurrently
- Multiple, incremental overlays of different supplemental forcings
- Optional data masks



No mask applied



CONUS mask applied

Incremental forcing overlays

Incremental forcing overlays

```
Base forcing source:                                     1  # GDAS
Number of base forcing variables:                        10
Use elevation correction (base forcing):                 1  #1-use lapse rate
Spatial interpolation method (base forcing):             1  #1-bilinear
Temporal interpolation method (base forcing):            1  #1-linear
Number of supplemental forcing sources:                  3  # 0 or higher
Supplemental forcing sources:                            4  2 16 # NLDAS+CMAP+STAGEIV
Number of supplemental forcing variables:                10 1  1
Use elevation correction (supplemental forcing):         0  0 0 #1-use lapse rate
Spatial interpolation method (supplemental forcing):     1  2  2
Temporal interpolation method (supplemental forcing):    1  1 1
```

Incremental forcing overlays

```
Base forcing source:                              1  # GDAS
Number of base forcing variables:                 10
Use elevation correction (base forcing):          1  #1-use lapse rate
Spatial interpolation method (base forcing):      1  #1-bilinear
Temporal interpolation method (base forcing):     1  #1-linear
Number of supplemental forcing sources:           3  # 0 or higher
Supplemental forcing sources:                     4  2 16 # NLDAS+CMAP+STAGEIV
Numbe
Use ele
Spatial
Tempor
```

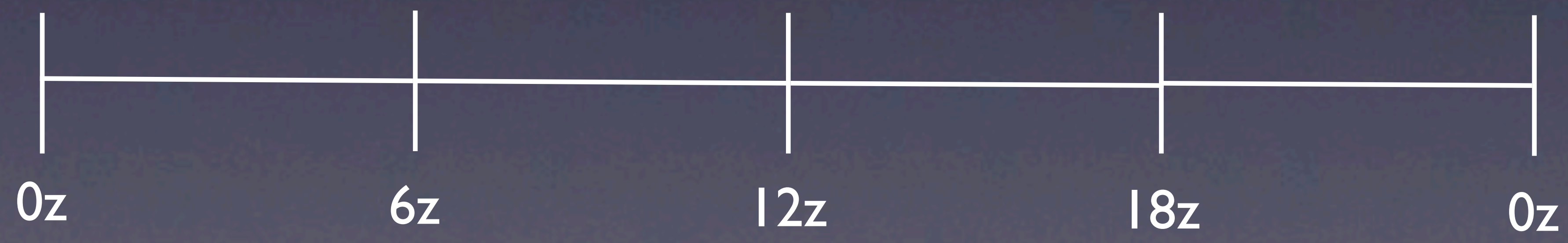
```
#ALMA Name  select vlevels  units
Tair:        1  1  K        # Near Surface Air Temperature
Qair:        1  1  kg/kg    # Near Surface Specific Humidity
SWdown:      1  1  W/m2     # Incident Shortwave Radiation
SWdirect:    0  1  W/m2     # Incident Shortwave Radiation
SWdiffuse:   0  1  W/m2     # Incident Shortwave Radiation
LWdown:      1  1  W/m2     # Incident Longwave Radiation
Wind_E:      1  1  W/m2     # Eastward Wind
Wind_N:      1  1  m/s      # Northward Wind
Psurf:       1  1  Pa       # Surface Pressure
Rainf:       1  1  kg/m2s   # Rainfall Rate
Snowf:       0  1  kg/m2s   # Snowfall Rate
CRainf:      1  1  kg/m2s   # Convective Rainfall Rate
Forc_Hgt:    0  1  m        # Height of Forcing Variables
Ch:          0  1  -        # Surface Exchange Coefficient for Heat
```

Incremental data assimilation overlays

Allows concurrent instances of data assimilation

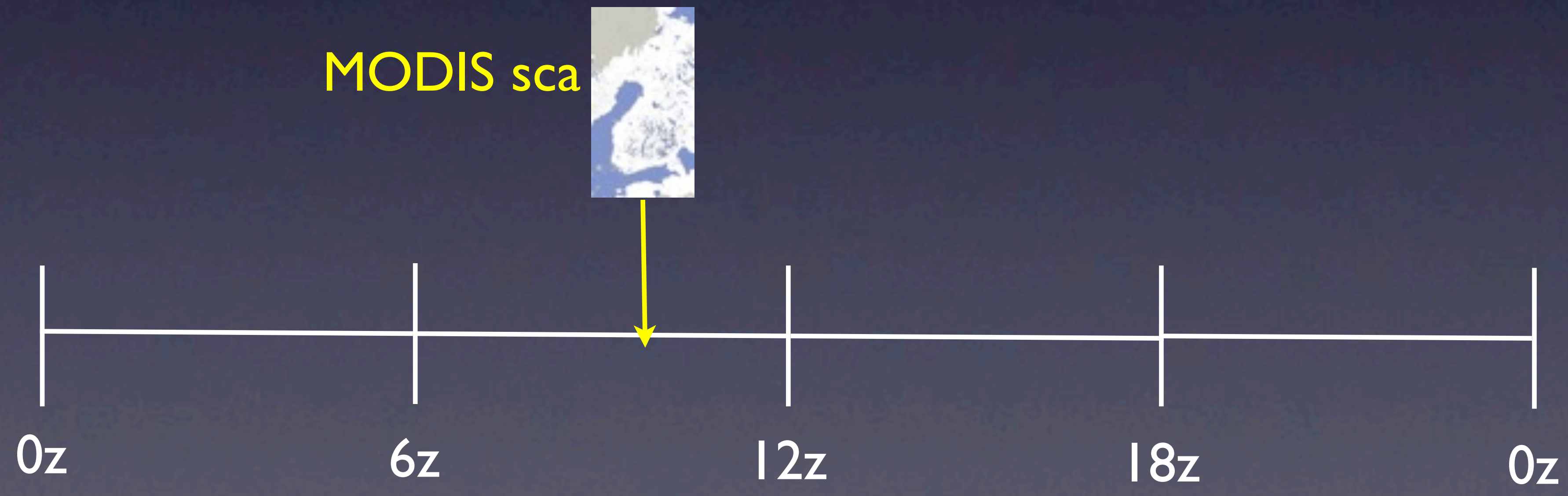
Incremental data assimilation overlays

Allows concurrent instances of data assimilation



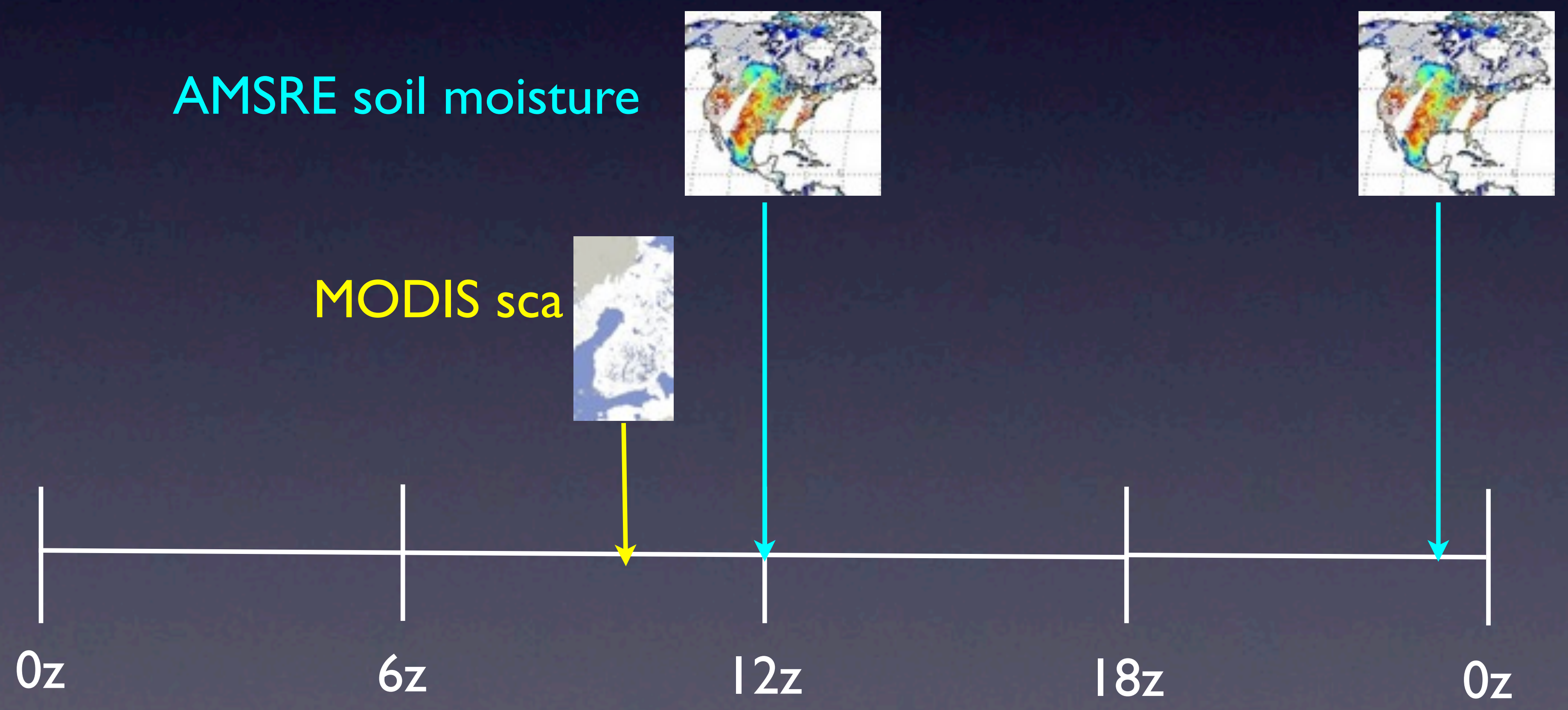
Incremental data assimilation overlays

Allows concurrent instances of data assimilation



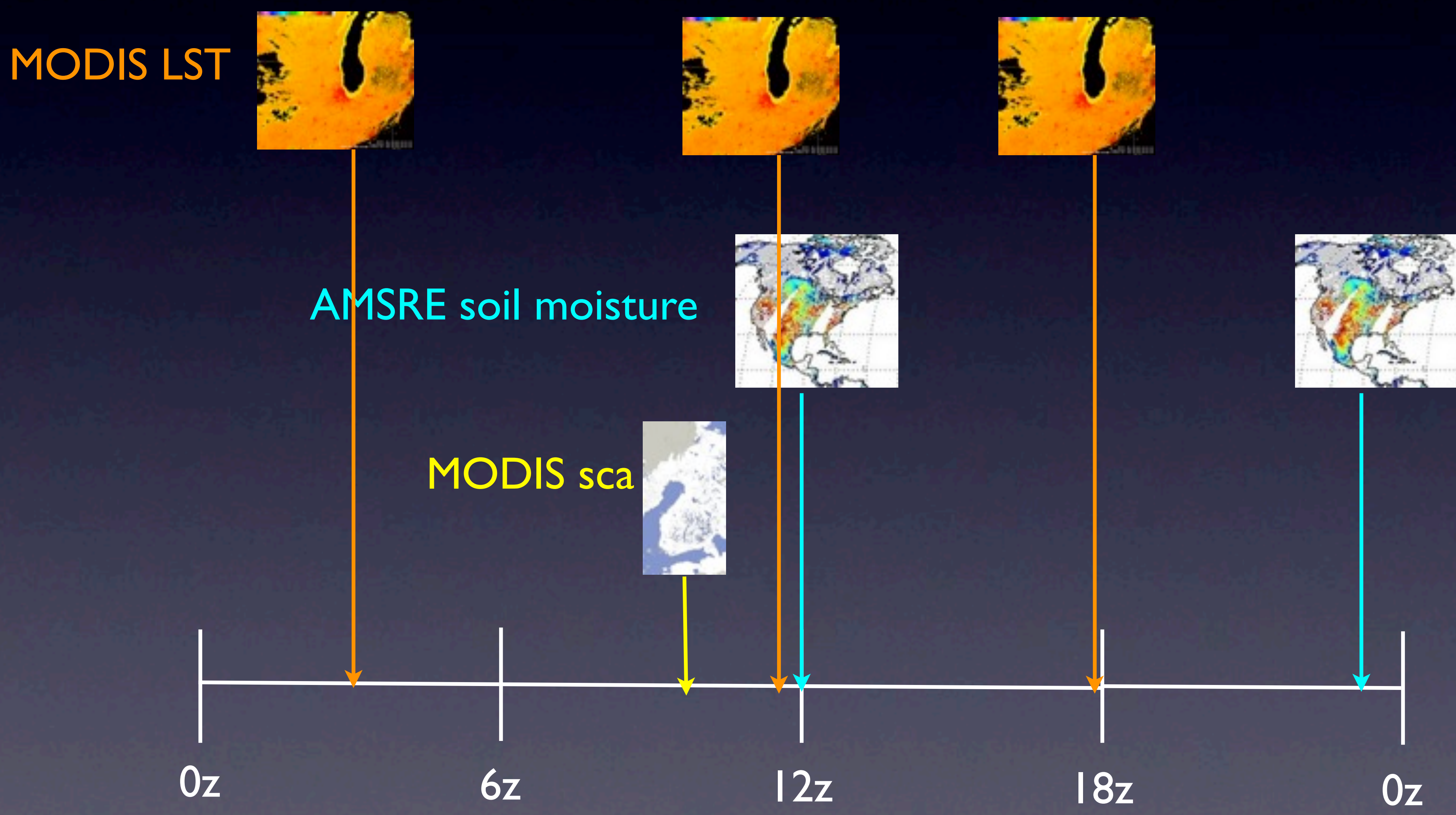
Incremental data assimilation overlays

Allows concurrent instances of data assimilation



Incremental data assimilation overlays

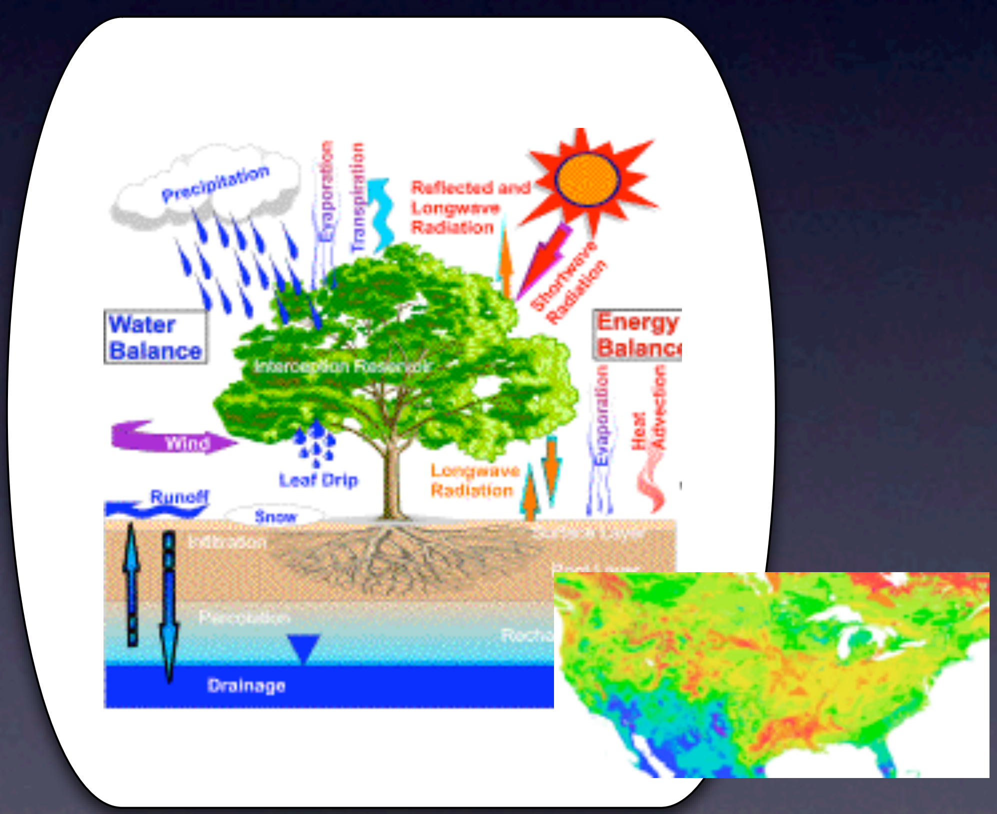
Allows concurrent instances of data assimilation



ESMF-compliant coupling to WRF

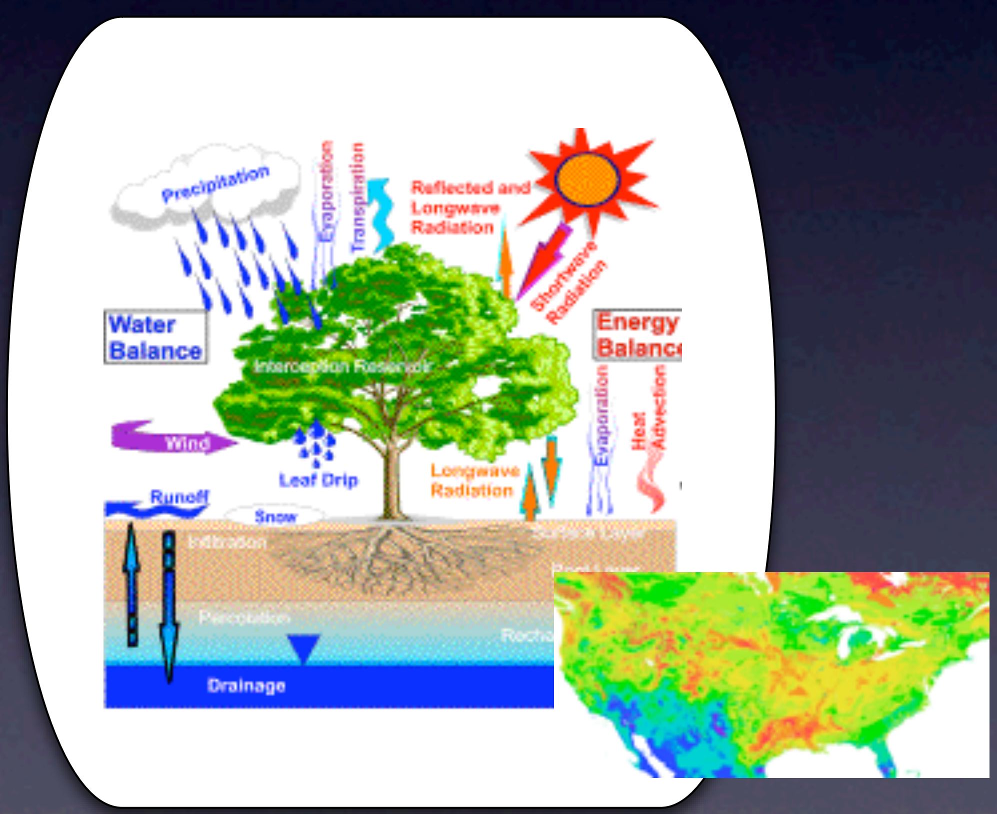
ESMF-compliant coupling to WRF

LIS

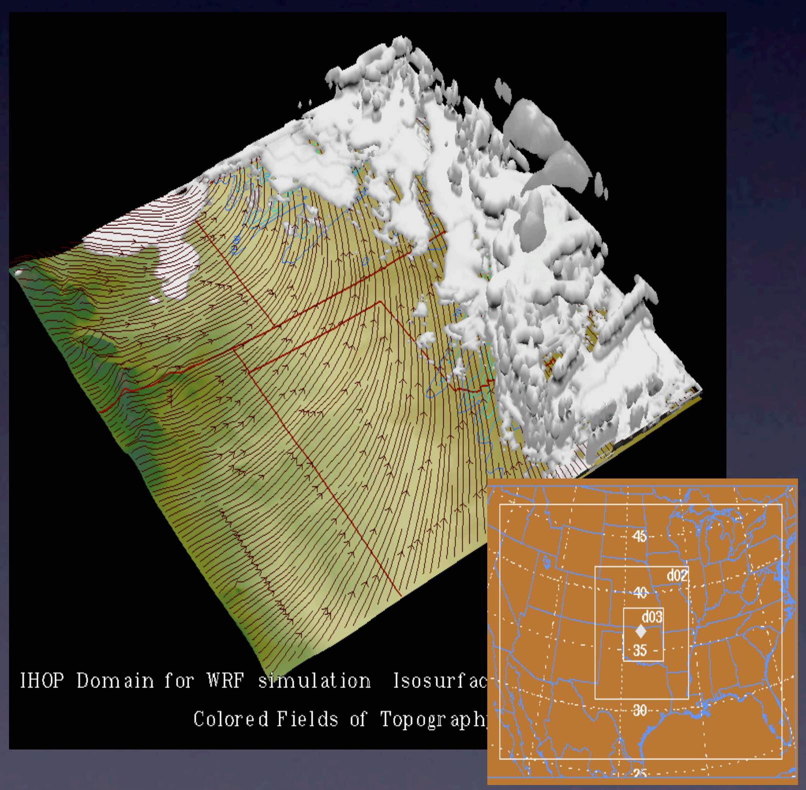


ESMF-compliant coupling to WRF

LIS

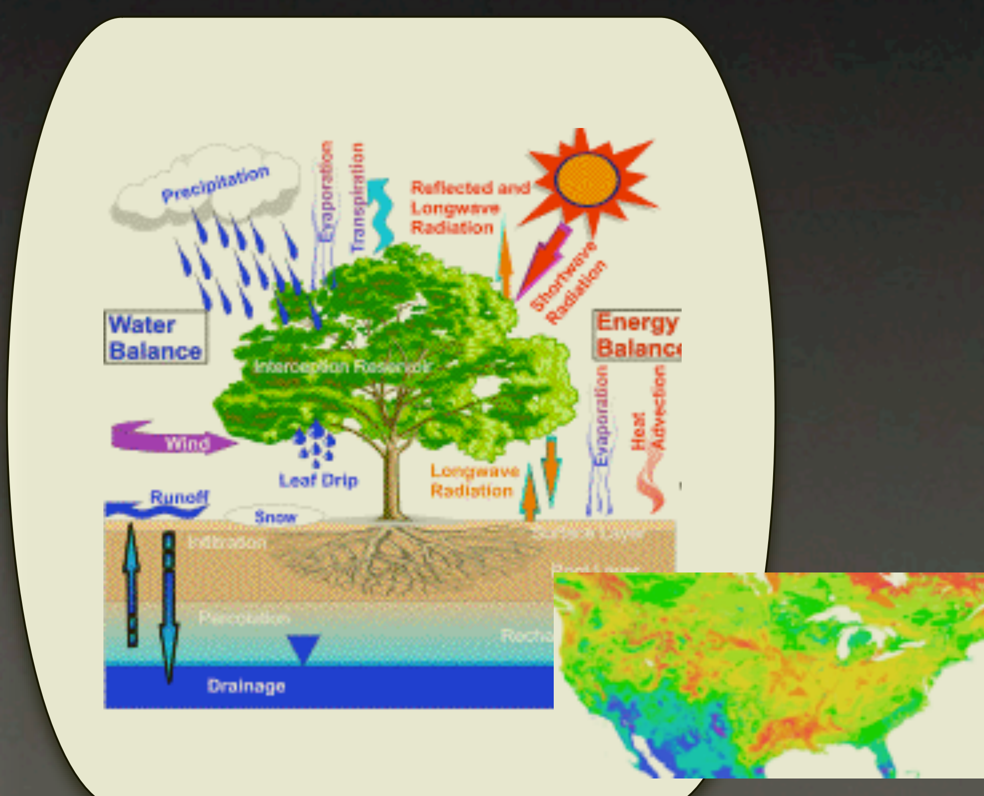


WRF



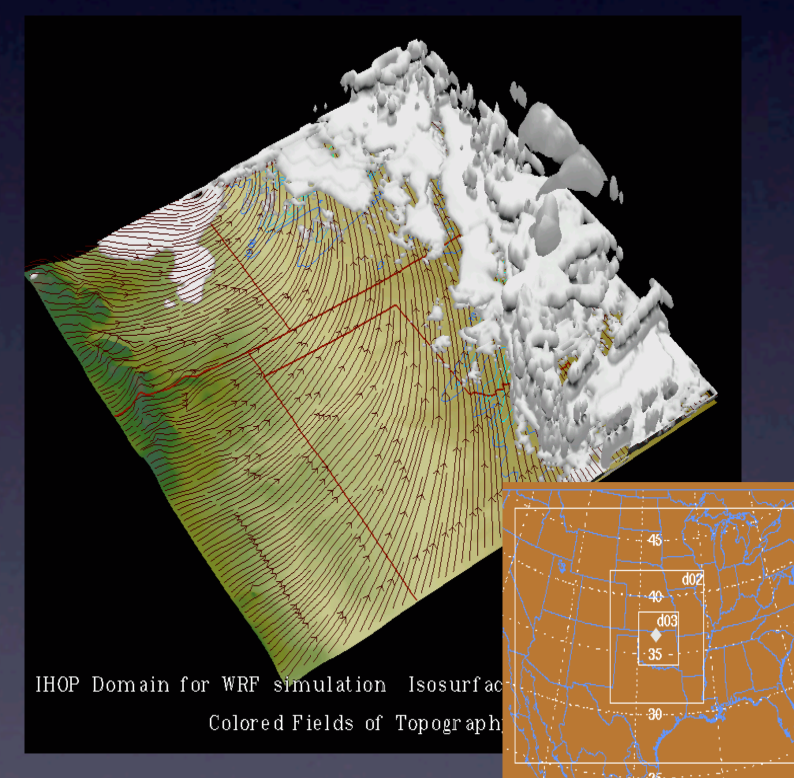
ESMF-compliant coupling to WRF

LIS



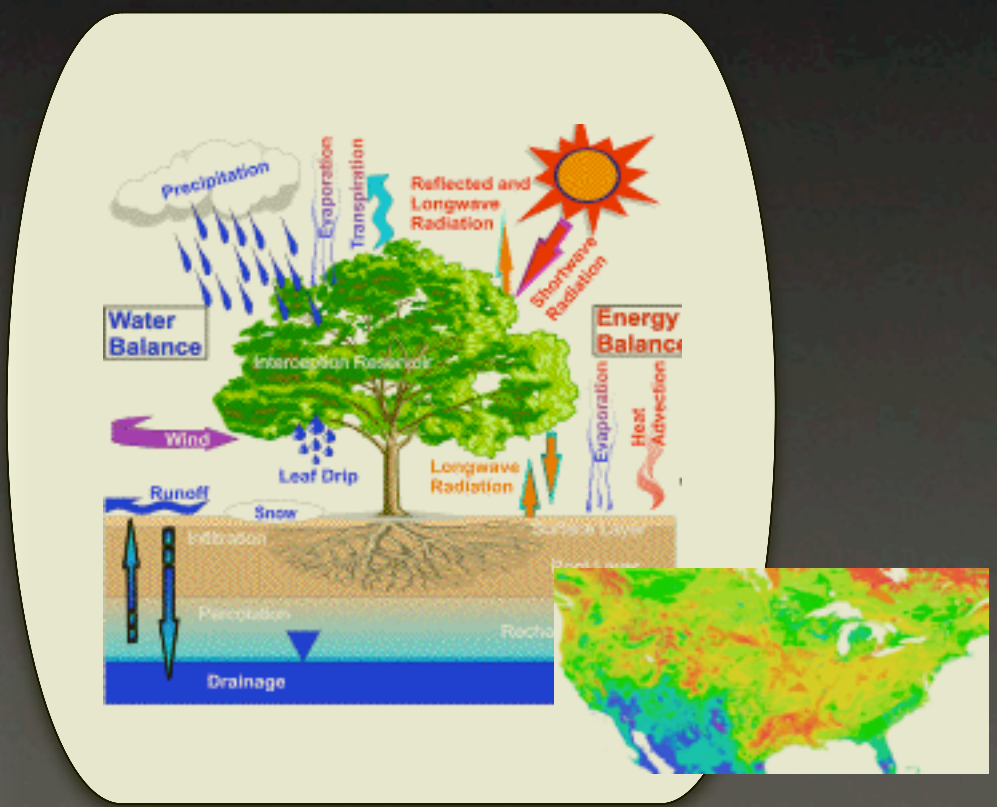
ESMF Gridded Component

WRF



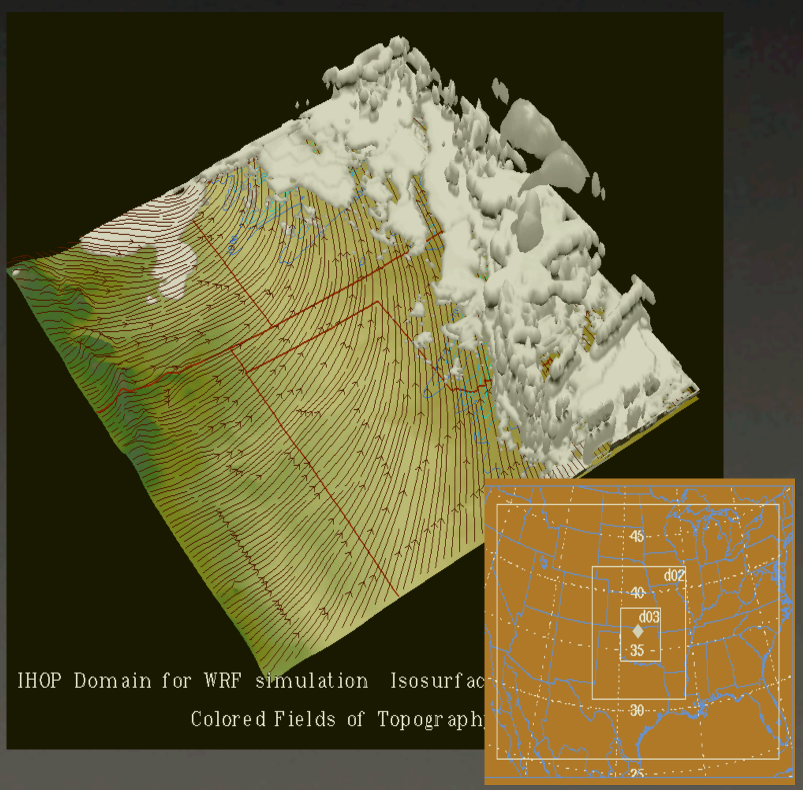
ESMF-compliant coupling to WRF

LIS



ESMF Gridded Component

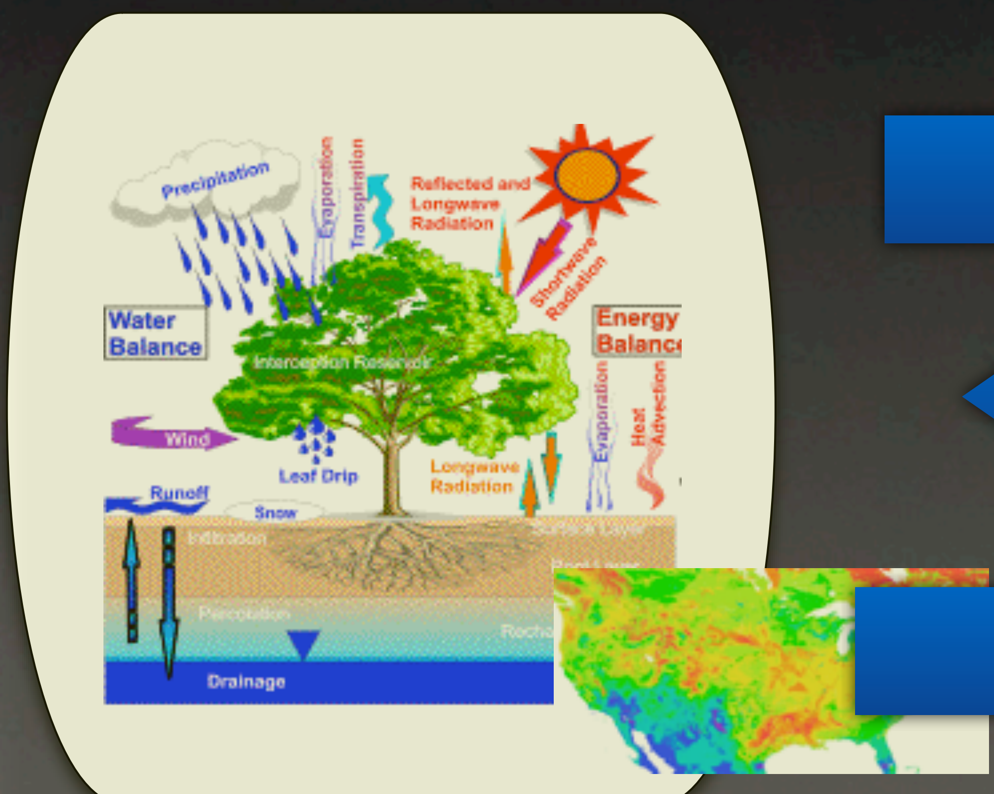
WRF



ESMF Gridded Component

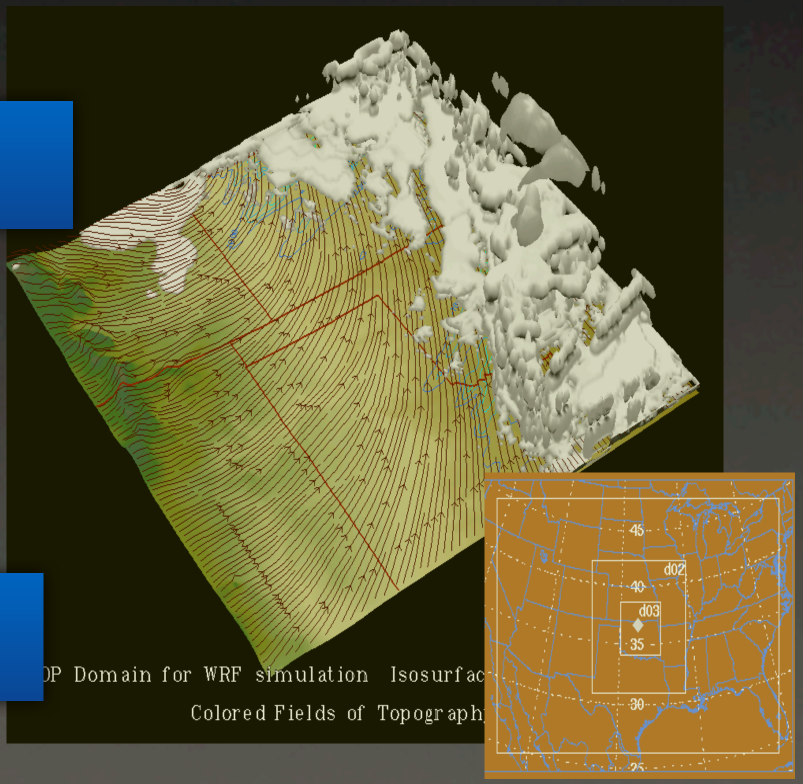
ESMF-compliant coupling to WRF

LIS



ESMF Gridded Component

WRF



ESMF Gridded Component

ESMF Coupler Component

LIS to WRF Coupler

ESMF Coupler Component

WRF to LIS coupler

Abstractions Layer Enhancements

Dynamic bias estimation

Dynamic bias estimation

Allows the incorporation of a dynamic bias estimation algorithms

Dynamic bias estimation

Allows the incorporation of a dynamic bias estimation algorithms

Data Assimilation

Dynamic bias estimation

Allows the incorporation of a dynamic bias estimation algorithms

Data Assimilation

Refined interfaces (More QA/QC options, I/O of processed observations)

Dynamic bias estimation

Allows the incorporation of a dynamic bias estimation algorithms

Data Assimilation

Refined interfaces (More QA/QC options, I/O of processed observations)

Land Surface Parameters

Dynamic bias estimation

Allows the incorporation of a dynamic bias estimation algorithms

Data Assimilation

Refined interfaces (More QA/QC options, I/O of processed observations)

Land Surface Parameters

Eliminated map projection dependencies

Radiative Transfer Models

Radiative Transfer Models

Allows the incorporation of radiative transfer and forward modeling methods

Radiative Transfer Models

Allows the incorporation of radiative transfer and forward modeling methods

Towards a radiance-based data assimilation system

Radiative Transfer Models

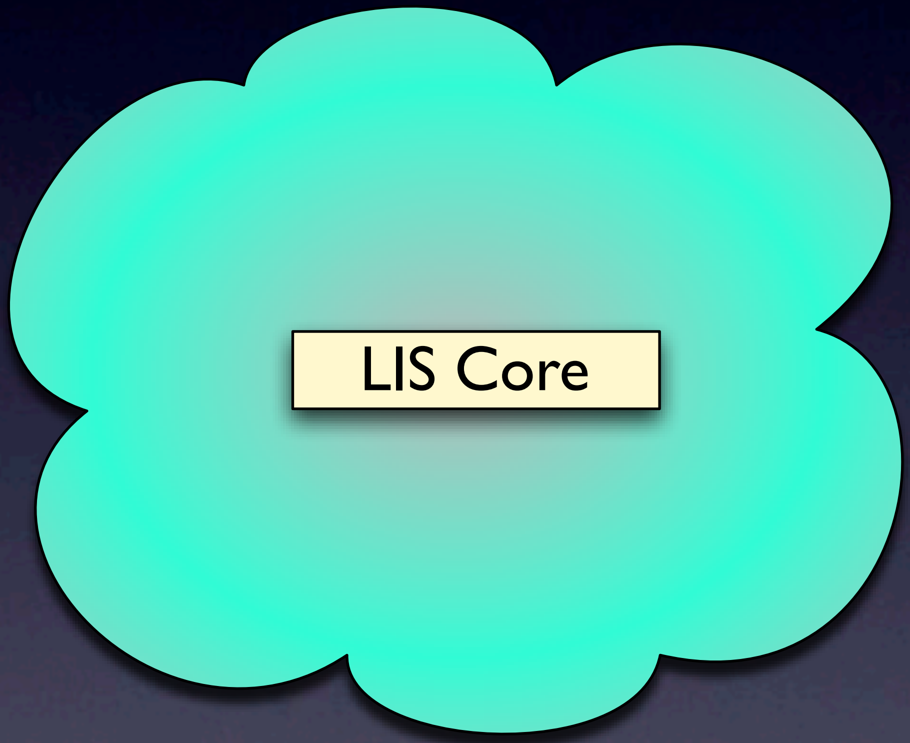
Allows the incorporation of radiative transfer and forward modeling methods

Towards a radiance-based data assimilation system

Radiative Transfer Models

Allows the incorporation of radiative transfer and forward modeling methods

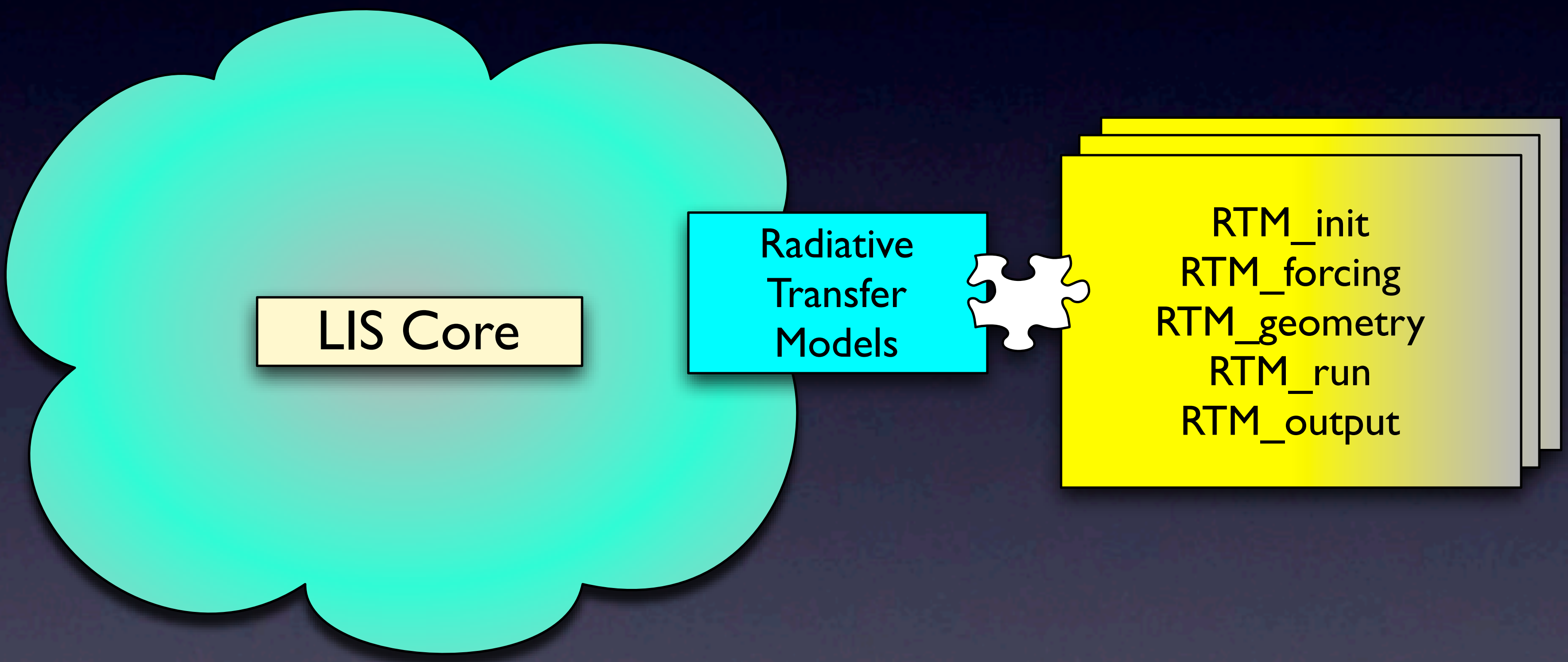
Towards a radiance-based data assimilation system



Radiative Transfer Models

Allows the incorporation of radiative transfer and forward modeling methods

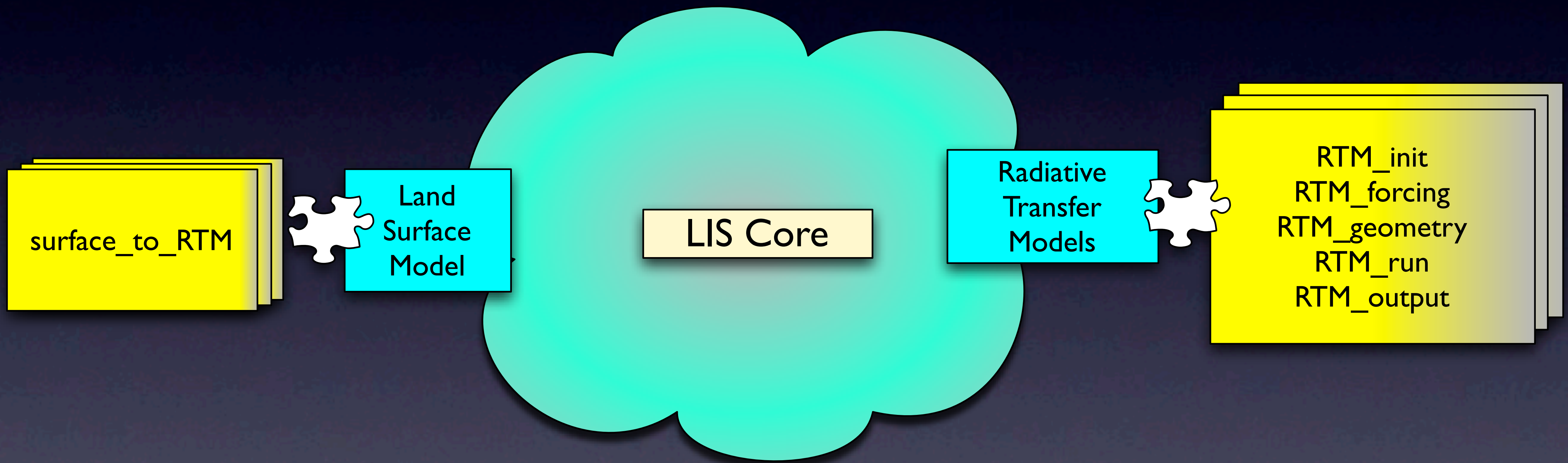
Towards a radiance-based data assimilation system



Radiative Transfer Models

Allows the incorporation of radiative transfer and forward modeling methods

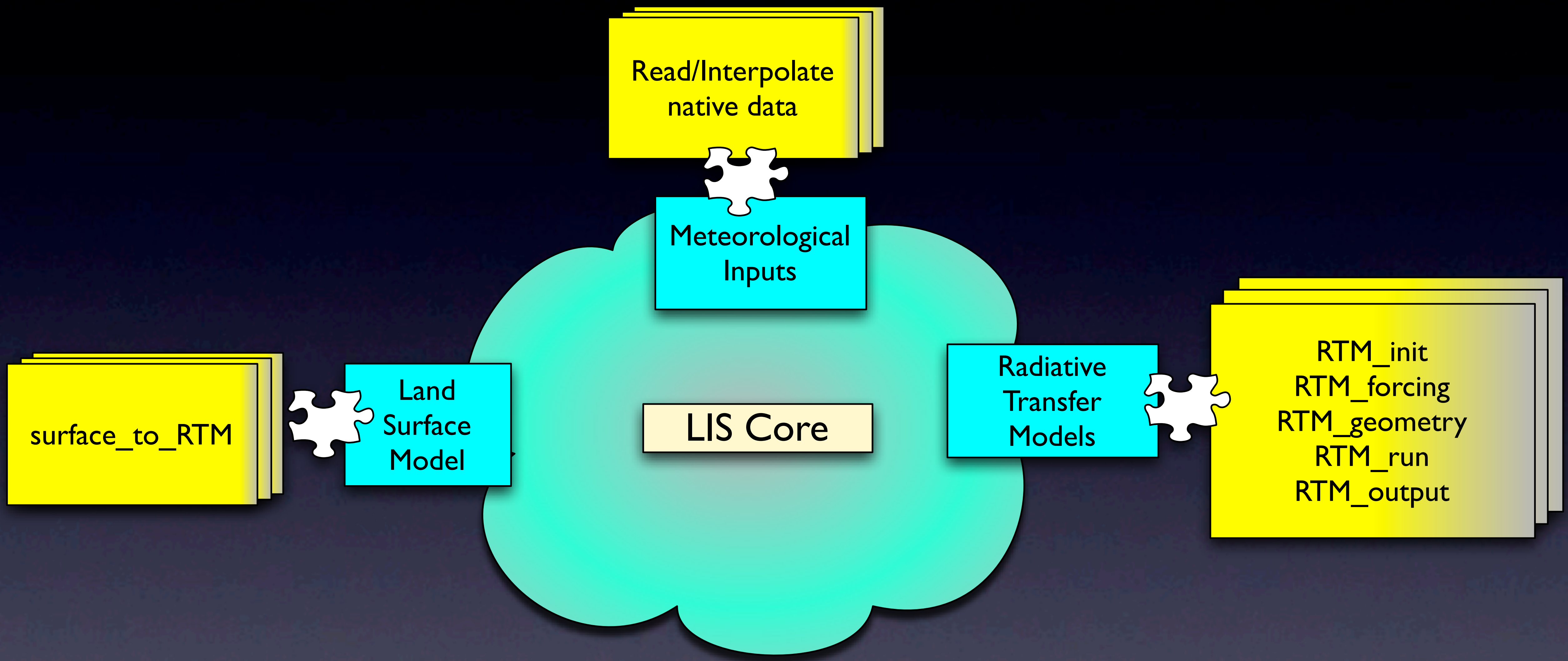
Towards a radiance-based data assimilation system



Radiative Transfer Models

Allows the incorporation of radiative transfer and forward modeling methods

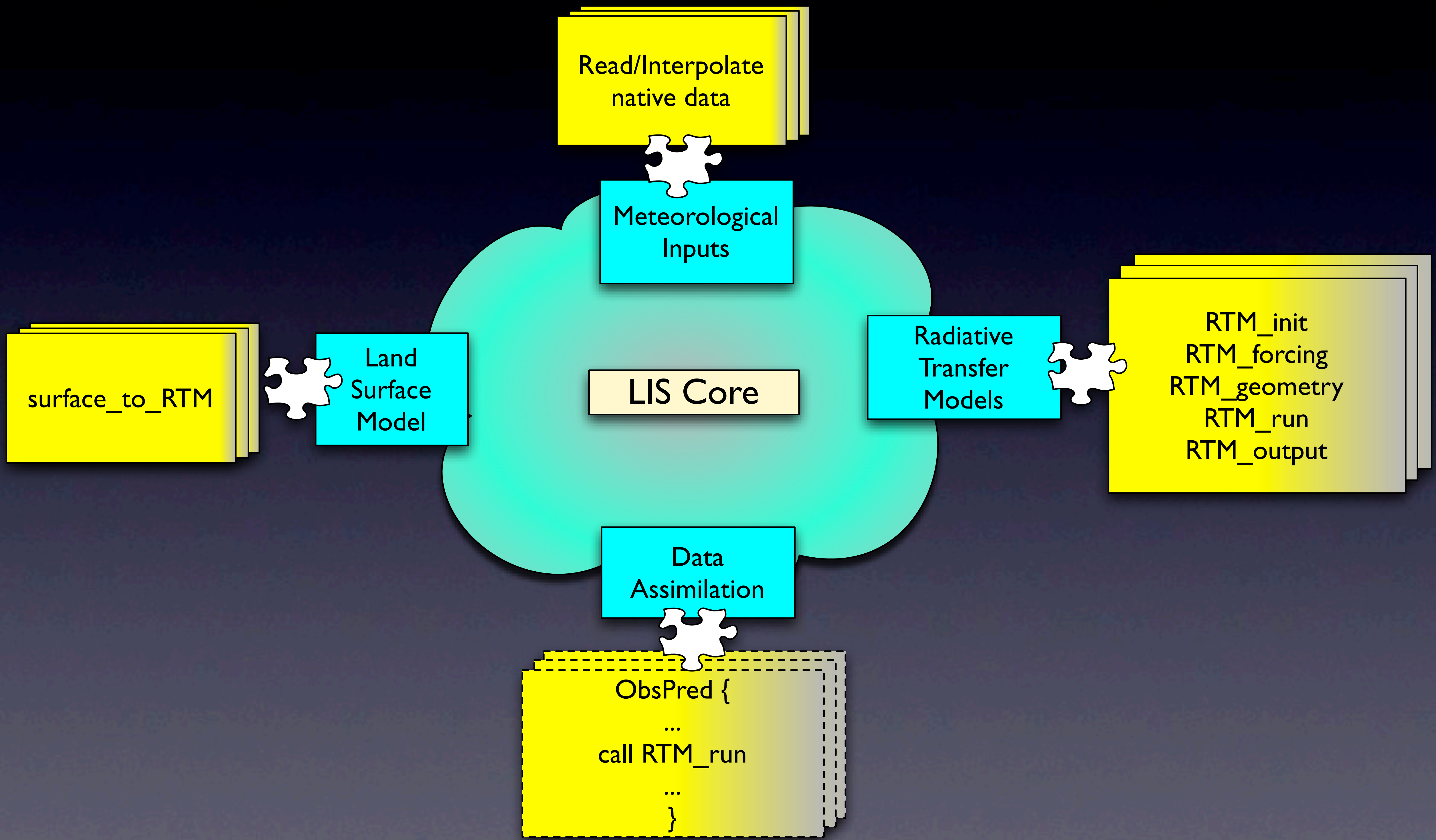
Towards a radiance-based data assimilation system



Radiative Transfer Models

Allows the incorporation of radiative transfer and forward modeling methods

Towards a radiance-based data assimilation system



Optimization

Optimization

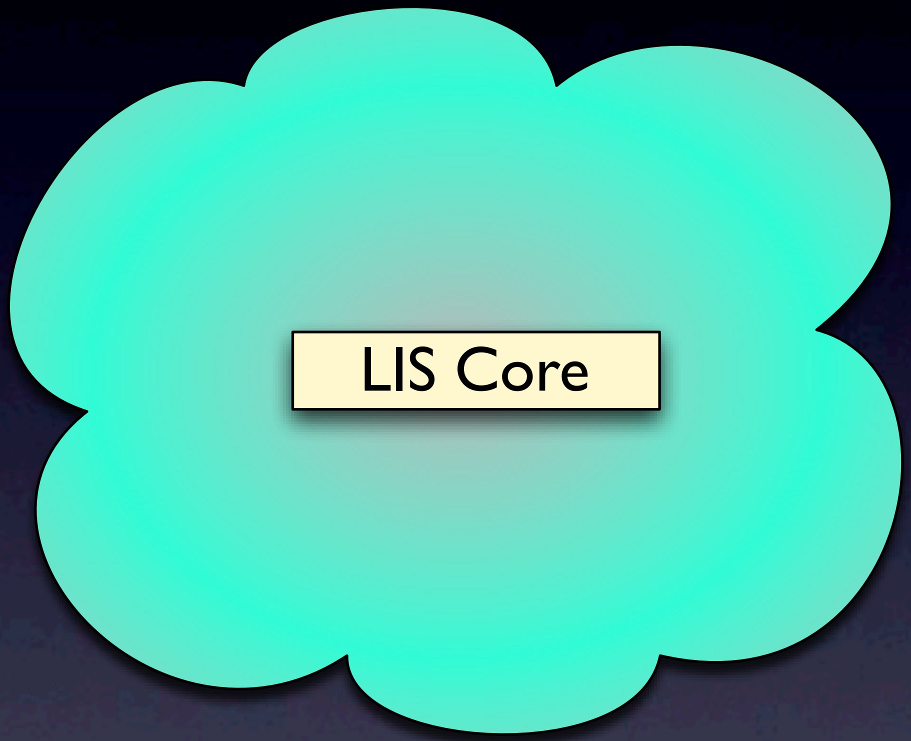
Allows the incorporation of optimization algorithms

Optimization

Allows the incorporation of optimization algorithms

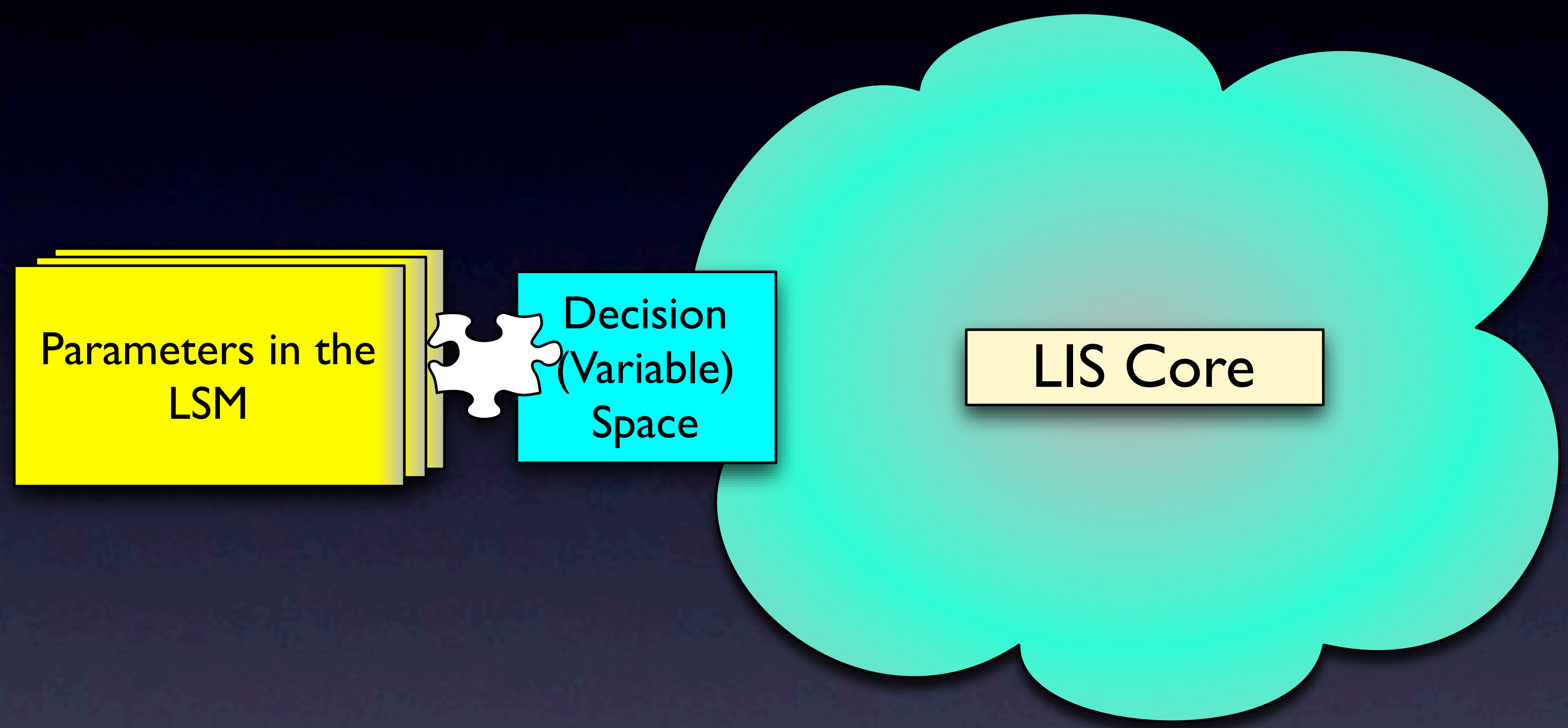
Optimization

Allows the incorporation of optimization algorithms



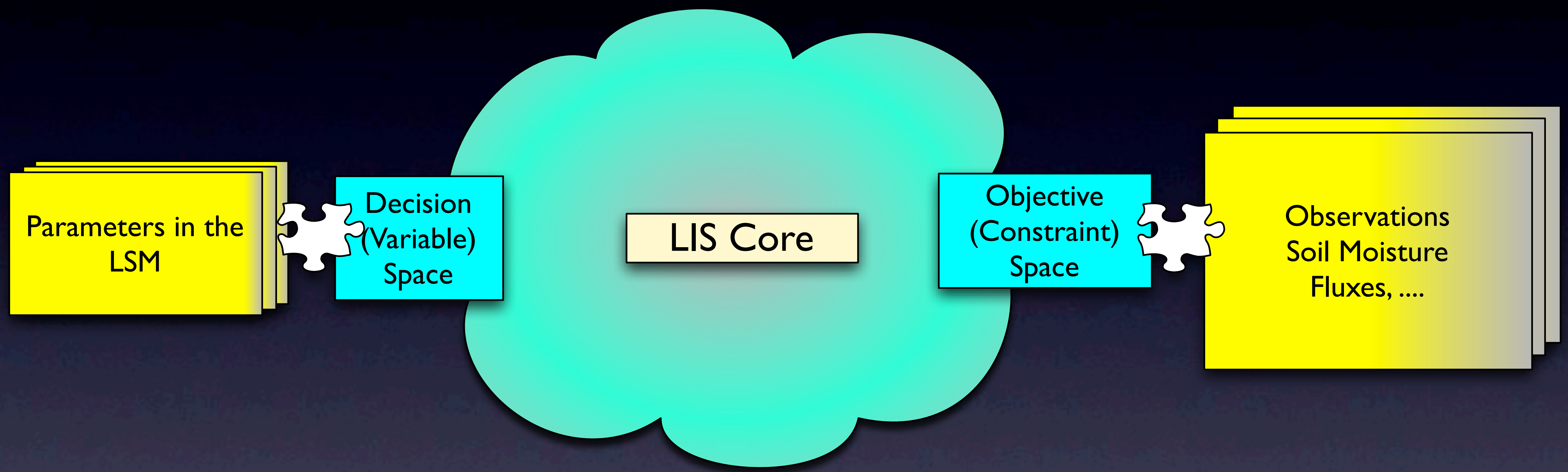
Optimization

Allows the incorporation of optimization algorithms



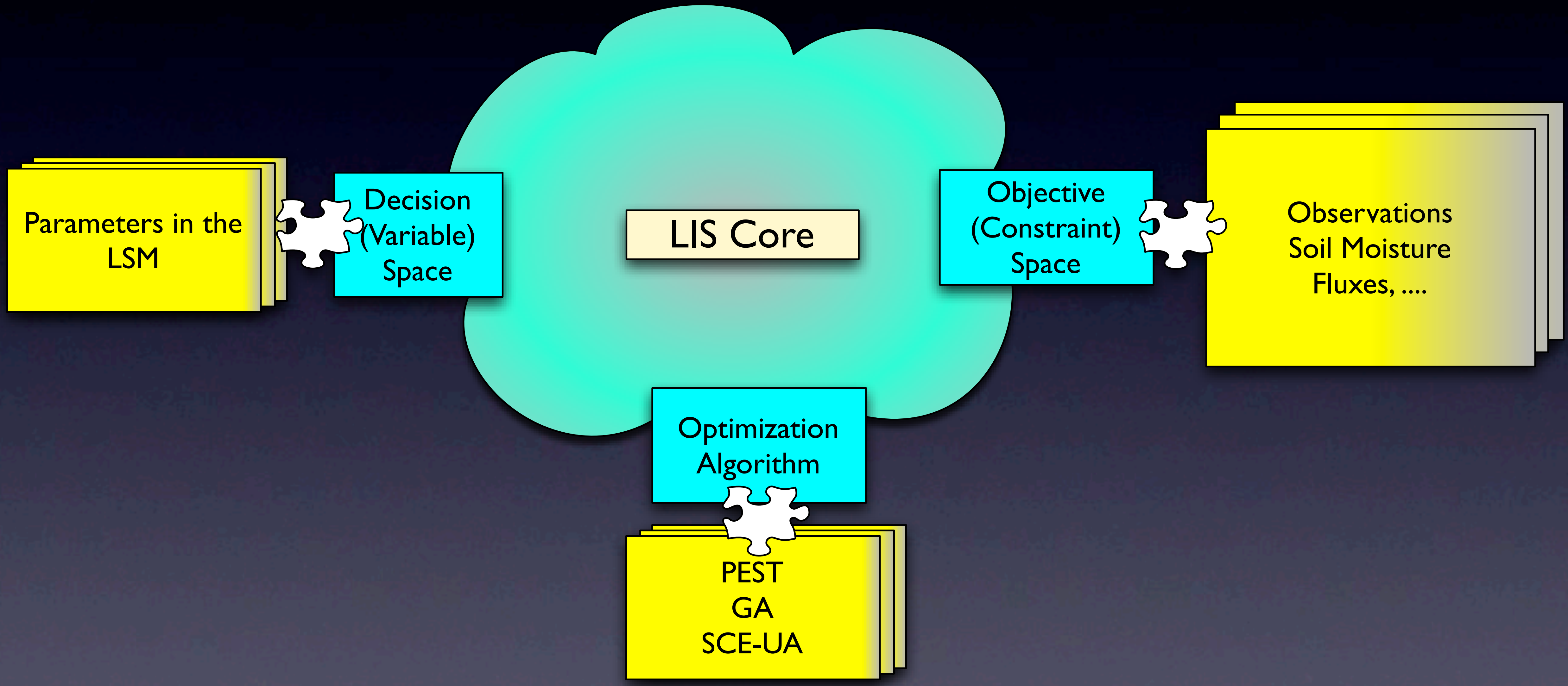
Optimization

Allows the incorporation of optimization algorithms



Optimization

Allows the incorporation of optimization algorithms



Model Layer Additions

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL, PLACE, CLM3.5

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL, PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL, PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

Meteorological Forcing: GFS, GDAS (reads 9hr forecasts), GEOS (reads GEOS5 format), NARR profiles; NLDAS, NLDAS-II, SALDAS redesigned as supplemental forcings

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL, PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

Meteorological Forcing: GFS, GDAS (reads 9hr forecasts), GEOS (reads GEOS5 format), NARR profiles; NLDAS, NLDAS-II, SALDAS redesigned as supplemental forcings

Dynamic bias estimation: GMAO bias estimation algorithm (Dee 2003)

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL, PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

Meteorological Forcing: GFS, GDAS (reads 9hr forecasts), GEOS (reads GEOS5 format), NARR profiles; NLDAS, NLDAS-II, SALDAS redesigned as supplemental forcings

Dynamic bias estimation: GMAO bias estimation algorithm (Dee 2003)

Optimization: PEST, Genetic Algorithm, SCE-UA

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL, PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

Meteorological Forcing: GFS, GDAS (reads 9hr forecasts), GEOS (reads GEOS5 format), NARR profiles; NLDAS, NLDAS-II, SALDAS redesigned as supplemental forcings

Dynamic bias estimation: GMAO bias estimation algorithm (Dee 2003)

Optimization: PEST, Genetic Algorithm, SCE-UA

Radiative Transfer Models: CRTM

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL,PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

Meteorological Forcing: GFS, GDAS (reads 9hr forecasts), GEOS (reads GEOS5 format), NARR profiles; NLDAS, NLDAS-II, SALDAS redesigned as supplemental forcings

Dynamic bias estimation: GMAO bias estimation algorithm (Dee 2003)

Optimization: PEST, Genetic Algorithm, SCE-UA

Radiative Transfer Models: CRTM

Land Surface Parameters: Real-time GVF (AVHRR, MODIS), MODIS (C5) landcover, LAI, GVF, albedo

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL,PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

Meteorological Forcing: GFS, GDAS (reads 9hr forecasts), GEOS (reads GEOS5 format), NARR profiles; NLDAS, NLDAS-II, SALDAS redesigned as supplemental forcings

Dynamic bias estimation: GMAO bias estimation algorithm (Dee 2003)

Optimization: PEST, Genetic Algorithm, SCE-UA

Radiative Transfer Models: CRTM

Land Surface Parameters: Real-time GVF (AVHRR, MODIS), MODIS (C5) landcover, LAI, GVF, albedo

Data Assimilation: AMSR-E soil moisture (NASA, USDA, UVA), ISCCP LST, MODIS SCA (standard and gap-filled), ANSA

LSMs: Noah 3.1 (supports concurrent use of multiple Noah versions), TESSEL, PLACE, CLM3.5

Running Mode: RTM forward mode, Parameter estimation mode

Meteorological Forcing: GFS, GDAS (reads 9hr forecasts), GEOS (reads GEOS5 format), NARR profiles; NLDAS, NLDAS-II, SALDAS redesigned as supplemental forcings

Dynamic bias estimation: GMAO bias estimation algorithm (Dee 2003)

Optimization: PEST, Genetic Algorithm, SCE-UA

Radiative Transfer Models: CRTM

Land Surface Parameters: Real-time GVF (AVHRR, MODIS), MODIS (C5) landcover, LAI, GVF, albedo

Data Assimilation: AMSR-E soil moisture (NASA, USDA, UVA), ISCCP LST, MODIS SCA (standard and gap-filled), ANSA

Useful (unsupported!) utilities

Ensemble restart generator: Generates a restart file for an ensemble run from a single ensemble member restart file

Ensemble restart generator: Generates a restart file for an ensemble run from a single ensemble member restart file

GrADS control file generator: Generates a GrADS control file for a LIS simulation

Ensemble restart generator: Generates a restart file for an ensemble run from a single ensemble member restart file

GrADS control file generator: Generates a GrADS control file for a LIS simulation

Restart Converter: Generates a fine resolution restart file from a coarse resolution LIS restart file

Ensemble restart generator: Generates a restart file for an ensemble run from a single ensemble member restart file

GrADS control file generator: Generates a GrADS control file for a LIS simulation

Restart Converter: Generates a fine resolution restart file from a coarse resolution LIS restart file

More to come.... Contributions encouraged....

Caveats

- No “public” release yet
- Considerable changes to LIS configuration
- Documentation and Testcases are still being updated